Transportation Synthesis Report

Nina McLawhorn
Research Administrator
Wisconsin Department of Transportation
608-266-3199
nina.mclawhorn@dot.state.wi.us

Warm-Mix Asphalt Pavement – State of the Practice in the U.S.

Prepared for
Wisconsin Highway Research Program
WisDOT Bureau of Project Development
Division of Transportation System Development

Prepared by
CTC & Associates LLC
WisDOT Research and Communication Services
November 18, 2005

Transportation Synthesis Reports (TSRs) are brief summaries of currently available information on topics of interest to WisDOT technical staff and partners. Online and print sources include NCHRP and other TRB programs, AASHTO, the research and practices of other state DOTs, and related academic and industry research. Internet hyperlinks in TSRs are active at the time of publication, but changes on the host server can make them obsolete.

REQUEST FOR REPORT

The Flexible Pavement Technical Oversight Committee of the Wisconsin Highway Research Program asked for a report on the state-of-the-practice in warm-mix asphalt pavement technology in the United States. Of specific interest were asphalt mix temperature ranges and transportation agencies that have been employing the technology in a mature way, not limited to pilot projects or single installations.

SUMMARY

Warm-mix asphalt pavement technology remains in its infancy in the United States. Adopted from Europe, where high energy costs have propelled efforts to reduce heating needs in every field, warm-mix asphalt entails the use of additives in asphalt binders designed to soften the binder, allowing workability and compactibility at lower temperatures than with traditional hot-mix asphalt. Generally, warm-mix seems to entail production temperatures at under 300 degrees F; anything above is considered hot-mix asphalt

Following an FHWA tour, the technology started gaining attention in 2003 with industry efforts to promote the technology. A demonstration project in 2004 at the World of Asphalt Show and Conference laid warm-mix in Charlotte, NC, and the much-anticipated pilot enjoyed coverage in trade journals throughout 2003 and 2004. (See, for example, a preview at http://www.betterroads.com/Advertisers/worldofasphaltguide.htm#WarmMix.) At the December 2003 Wisconsin Asphalt Pavement Conference a presentation by the National Center for Asphalt Technology piqued badger state interest (http://meadandhunt.com/News/pr_04/wapa.htm).

There are to this point only pilot installations in the U.S. In 2004 three were conducted, including installations in Charlotte, N.C., Nashville, Tenn., and Orlando, Flor. According to NCAT, three more were to be conducted in 2005. Though FHWA has since 2003 devoted a web page to the technology, the only significant research on the technology has been NCAT studies of specific additives in warm-mix applications, published in 2005.

At this time warm-mix remains a nascent technology in this country, a topic of interest but not yet thoroughly researched or implemented on anything but a cautious, experimental scale.

NATIONAL CENTER FOR ASPHALT TECHNOLOGY

NCAT seems to spearhead research on warm-mix asphalt technology in this country. The reports that follow seem to be the first of their kind in the U.S.

NCAT Report 05-04: Evaluation of Aspha-Min ® Zeolite for Use in Warm Mix Asphalt; Brian D. Prowell and Graham C. Hurley. June 2005. Focused on reducing mix and compaction temperatures of HMA employing crystalline hydrate aluminum silicate. Compactibility improved, air voids were reduced, and resilient modulus and

rutting potential were unharmed in lab study, which found compaction improved at temperatures as low as 190 degrees F. Lower compaction and mixing temperatures did diminish rutting performance. Field study in Florida employed a control at 300 degrees F for compaction, and 265 degrees F for the demo; tests echoed lab results, and one-year cores of control and demo showed no moisture damage differences. See http://www.eng.auburn.edu/center/ncat/reports/rep05-04.pdf.

NCAT Report 05-06: Evaluation of Sasobit ® for Use in Warm Mix Asphalt; Brian D. Prowell and Graham C. Hurley. June 2005. Findings essentially echo those of the Aspha-Min lab study, this time with a synthetic wax additive to the binder. SGC results suggest the additive may allow reducing asphalt content, and improved compactibility and reduced air voids followed. Compaction also improved at 190 degrees F, and rutting potential and resilient modulus again remain unaffected; again, rutting potential rose with decreasing mix and compaction temperatures. No field demo was used. See http://www.eng.auburn.edu/center/ncat/reports/rep05-06.pdf.

RESEARCH IN PROGRESS

The following study shows the nascent state of research on warm-mix asphalt in its focus on literature searches and analysis.

Texas Transportation Institute: Review of Warm Mix Asphalt in the US. Sept. 2005 through Aug. 2006. The work plan shows a focus on literature searches and interviews, as well as data analysis; no field work seems to be involved. See http://swutc.tamu.edu/ProjectDescriptions/FY06highway.html#473700-00080.

GENERAL DESCRIPTIONS

The following two pieces offer excellent technical overviews of the technology.

Asphalt Institute. "Warm Mix Asphalt Pavements: Technology of the Future?," *Asphalt*, Fall 2004; pp. 8-11. This article claims working temperatures can be reduced by as much as 100 degrees F, and describes three additive-based processes: a synthetic zeolite powder, a two-stage foam process, and an organic additive process employing synthetic paraffin wax or ester. https://www.asphaltinstitute.org/Upload/2004_Fall_Mag_Warm_Mix_Asphalt_Pavements.pdf. See also a story in a Missouri asphalt newsletter that echoes the Asphalt Institute article – p. 4 of http://www.moasphalt.org/news/2004_spring/MAPAnlSpring04.pdf. Most of this information probably originated in a NAPA journal piece from March/April 2004's *Hot Mix Asphalt Technology*, a document not available on the Internet.

"Warm Mixes are a Hot Topic," *Better Roads*, June 2004. Where other articles and web sites borrow or reprint the NAPA piece in the March/April 2004 edition of *Hot Mix Asphalt Technology* , this article expands on previous documents. It explores the technology more skeptically with respect to its originality, goes into much greater detail on the various warm-mix additives and technologies, and offers a thorough set of hyperlinks to relevant sites, including those of manufacturers and worker safety organizations (due to fume reduction). http://www.betterroads.com/articles/jun04e.htm.

NATIONAL SITES, TRADE NEWS

Many of the articles seem to build on press releases and studies from the asphalt industry and from NCAT. Several of the below articles, for instance, were authored by the NCAT investigators whose reports appear above. This suggests that the technology remains immature in this country.

FHWA Pavements: Warm Mix Asphalt Technologies and Research. This page describes warm-mix and its three principal additive approaches with various temperature savings from about 50 degrees F to 90 degrees. Note that the cut-off working temperature between hot-mix and warm-mix seems to be 300 degrees F. http://www.fhwa.dot.gov/pavement/asphalt/wma.cfm.

"Starting to Warm," *Roads and Bridges*, Aug. 2005. An up-to-date review of international and national practices, the article asserts that only three demonstration projects have been conducted in the U.S. to date. These include the World of Asphalt demo in Charlotte, N.C. in Sept. 2004, the Nashville, Tenn. site in March 2004, and the Feb. 2004 demonstration site in Orlando, Flor. The authors, Hurley and Prowell of the NCAT studies, also claim several new installations will be constructed in late 2005. See http://www.roadsbridges.com/rb/index.cfm/powergrid/rfah=|cfap=/CFID/80155/CFTOKEN/20155737/fuseaction/showArticle/articleID/6274.

"Warm-Mix Asphalt Heats Up," ***Southeast Construction*****, July 2005.** Describes the warm-mix pour in Charlotte, N.C. employing data from, among other things, the NCAT report on Aspha-Min. The warm-mix used was produced at 265-270 degrees F. See http://www.aggregateresearch.com/extarticle.asp?id=7453.

"Expect Cooler Temperatures," ***Roads and Bridges*****, Feb. 2005.** Another up-to-date review from the NCAT investigators. http://www.roadsbridges.com/rb/index.cfm/powergrid/rfah=|cfap=/CFID/80155/CFTOKEN/20155737/fuseaction/showArticle/articleID/5795.

Ohio DOT Final Report: ***Comparison and Definition of State DOT's Practices in Selection of Materials for Pavements*****; Aug. 2004.** A review of best practices, this study cites warm-mix asphalt as a promising prospective technology borrowed from Europe. It describes warm-mix as entailing two stages: a first, in which a soft binder is used at temperatures ranging from 100 to 120 degrees C; the second in which a harder binder in powder, emulsion or foam form is added. This produces a mixture that can be handled and compacted at temperatures as low as 80-90 degrees C. See especially § 5.2 of http://www.dot.state.oh.us/research/2004/Materials/14802-FR.PDF.

Asphalt Pavement Association of Oregon. "Warm Mix Asphalt Shows Promise for Cost Reduction, Environmental Benefit," ***Centerline*****, Fall 2003.** The article reports that warm-mix works at production temperatures 20 percent lower than hot-mix. Rather than working at temperatures of 300 degrees F, warm-mix can be done at 240 degrees F. See http://www.apao.org/docs/2003fallpages.pdf.